

SECTION 11846 HIGH PRESSURE GAS DISTRIBUTION PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and division 1 specification sections, apply to this section.

1.2 SUMMARY

- A. This section includes skid mounted panels for mounting small valves, gages, and instruments associated with high pressure gaseous helium and nitrogen.

1.3 SUBMITTALS

- A. The following shall be submitted in accordance with section 1300.
 - 1. Fabrication/layout drawings.
 - 2. Pipe rack hardware catalog sheets
 - 3. Support geometry and engineering data associated with mounting of large valves, dome pressure regulators, and relief valves with discharges larger than 3/4".
 - 4. An up-to-date "record set" of drawings shall be kept marked up with clearly legible indications of all changes made in the work.
 - 5. "As-built" fabrication drawings shall be delivered upon completion of the work.
 - 6. Field test reports indicating and interpreting test results relative to compliance with performance requirements of cleanliness and leakage.
 - 7. Pipe marking decals, color/service scheme.
 - 8. Layout drawing of controls and termination enclosures, instruments, electrical components and raceway on the Gas Panel.
 - 9. Schematic wiring diagram drawings of power distribution, controls and instrumentation, including wire labels.
 - 10. Interior layout of controls or termination enclosures showing FLEX-IO, wire duct, terminal blocks, power supplies and other major components within the enclosure.
 - 11. Electrical Test Plan

1.4 SEQUENCING AND SCHEDULING

- A. The vendor shall not ship any panels until written authorization to do so has been received from the contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. The vendor is responsible for the delivery of the panel skids and associated hardware. Any packing or protective crating shall be provided by the vendor.

1.6 REFERENCE MATERIALS

- A. Design drawings indicating the general arrangement of mechanical components and flow schematics are listed below:
 - 1. P7.50.34 - Helium and Nitrogen Distribution System P &ID, Ring Injection Dump Bldg Outside Panel
 - 2. J8E8520A031 - Helium and Nitrogen Panel Distribution System P&ID, Ring Injection Dump Bldg. Inside Panel
 - 3. P7.50.32 - Helium System Truck Fill Station Distribution, Target Building Outside Panel



DEPARTMENT OF ENERGY

SPALLATION NEUTRON SOURCE

OAK RIDGE, TENNESSEE

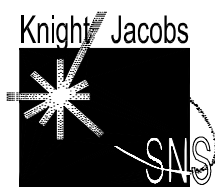
PROJECT SPECIFICATIONS

CERTIFIED FOR CONSTRUCTION

TARGET UTILITIES

WBS 1.6.6	CONTRACT NO. 00F-1660-2	
	Target Utilities	Bldg 8700
		Bldg 8520

January 18, 2002



**SECTION 00001
SPECIFICATION REVISION MATRIX**

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Matrix showing each Specification Section's current revision number.

1.2 PURPOSE

- A. This Specification is to be used in association with the following construction package only:

**CERTIFIED FOR CONSTRUCTION
TARGET UTILITIES**

CONTRACT NO. 00F-1660-2
WBS 1.6.6 Target Utilities Bldg 8700 and Bldg 8520

- B. The specification matrix below shows each section's current revision number applicable at the time of each construction package issue. Subsequent revisions to already issued sections will not affect existing construction packages already awarded unless specifically addressed by Bulletin. This specification section, 00001 shall be included in all construction packages.
- C. The "Applicable Sections" column identifies with an X those sections applying to the construction contract identified in Paragraph A above. Those specification sections that are listed below, but DO NOT have an X in the left hand column are not applicable, nor part of contract documents associated with the above contract title. The three columns under the "SNS Control No." to the right of the specification title is the document control number with the latest revision number of each section. Letter identified revisions have not been awarded to any contractor for construction purposes. Specifications with numbered revisions have been awarded to at least one contractor. The last column indicates the design office identifier with location (if necessary), which is responsible for creating and editing the specification section. This Section 00001 identifies the sections that make up each construction contract package and the revision status at the time of contract award. Sections subsequently awarded to another Contractor with a later revision number are not applicable to the previous Contract unless directed by a Bulletin.

Applicable Sections	Section	Section Title	SNS Control No.			Office
	Number		Doc Number	Sec No	Rev	
	Division 0 – CONTRACT INSTRUCTIONS					
X	00000	Design Team	108000000	TS0252	R60	KAT-SFO
X	00001	Specification Revision Matrix	108000000	TS0251	R60	KAT-SFO
X	00002	Professional in Responsible Charge	108000000	TS0070	R60	KAT-SFO
	Division 1 – GENERAL REQUIREMENTS					
X	General and Supplementary Conditions		108000000	TS0001	R03	Jacobs

4. J8E8700H510 – Helium and Nitrogen Panel Layout, Ring Injection Building.
 5. J8E8700A025 - Helium and Nitrogen Panel Distribution System P&ID, Target Building Sht 1
 6. J8E8700A026 - Helium and Nitrogen Panel Distribution System P&ID, Target Building Sht 2
 7. J8E8700A027 - Helium and Nitrogen Panel Distribution System P&ID, Target Building Sht 3
 8. J8E8700A028 - Helium and Nitrogen Panel Distribution System P&ID, Target Building Sht 4
 9. J8E8700H110 – Helium and Nitrogen Panel Layout, LWS1
 10. J8E8700H111 – Hot Cell Service Panel and Operator Gallery Gas Panel
 11. J8E8700H210 – Helium and Nitrogen Panel Layout, LWS2
 12. J8E8700H211 – Helium and Nitrogen Panel Layout, Proton Beam and Vacuum Pump Service Panel
 13. J8E8700H310 – Helium and Nitrogen Panel Layout, LWS3
 14. J8E8700H410 – Helium and Nitrogen Panel Layout, HWS4
 15. National Electric Code
 16. Allen Bradley 1794 FLEX-IO Distributed IO Installation Manual and Technical Reference
 17. Spallation Neutron Source Systems Requirement Document for Cabling, SNS 109010000-SR0001-R00
- B. Components and piping materials are specified in the following specification:
1. Spec 15455 – Helium and Nitrogen System Tubing and Components

1.7 SITE CONDITIONS

- A. The valve panel skids will be located outdoors and indoors at oak ridge, tennessee. Panel and pipe support structures shall be designed as indicated in attached sketch 001.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The referenced drawings define the equipment type and characteristics. If other brands and construction features are to be substituted, the vendor is expected to demonstrate performance comparable to the models specified in the referenced drawings, and suitability for the required service.
- B. All materials shall be new, unused.
- C. The gas wetted passages and connections shall be cleaned and field demonstrated per mil-std-1246c level 300 in accordance with the procedures identified in specification 15455. The vendor shall purchase factory cleaned components or obtain documented service cleaning for all scheduled components and maintain cleanliness conditions of all components throughout fabrication of the valve panel skids.
- D. The vendor shall furnish all miscellaneous items (pipe, tubing, wire, fasteners, fittings, support structures, etc.) Required for completion of skids.

2.2 PANEL SURFACE AND SUPPORT STRUCTURE MATERIALS

- A. The panel display surface material shall be approximately 0.1" thick (12 gage) low carbon, dry, commercial grade steel sheet. Protect panels against corrosion with zinc based rust resistant primer coating and alkyl enamel/epoxy type finish paint.
- B. Supporting structures shall be made of common structural channels or square tubing shapes with weather resistant painted surfaces.

- C. Support of pipelines, large valve/regulator components, etc. May be shop built-up from common structural components, or pre-fabricated systems such as unistrut.

2.3 HELIUM DISTRIBUTION PANEL – PLC CONTROLS ENCLOSURE AND INSTRUMENT WIRING INSTALLATION

- A. PLC Control - Vendor shall supply and install a NEMA 4 controls enclosure, Hoffman or equal, on the Helium Distribution Panel to house Allen Bradley (AB) FLEX-IO PLC equipment. This equipment consists of power supplies, a Controlnet network adapter, and the input/output (IO) modules of the type listed. The vendor is responsible for providing and installing all of all necessary hardware including modules, bases, power supplies, din rails and associated hardware and components to form a complete FLEX-IO distributed IO system such that the Gas Panel is controllable through a Controlnet network from a remote AB Controllogix PLC processor.
- B. Enclosure Space – Allow space in the enclosure for the Controlnet adaptor, and a total of eight (8) IO modules, along with the associated power supplies, wire duct and other equipment.
- C. Wire duct, Panduit or equal, shall be provided for cable routing within the enclosure. Wire duct for cable entry to the enclosure shall be provided in a clear area on the top or side for separate power and signal conduit entry.
- D. The FLEX-IO electrical interface to panel devices shall be 24 VDC for digital IO, and 24 VDC/4-20mA for analog inputs and outputs.
- E. Location - the controls enclosure shall be mounted in a location on the front of the panel such that access is unobstructed and that is easily accessible.
- F. Equipment within the controls enclosure shall be din rail mounted in a location where access is unobstructed with internal devices easily accessible from the front of the enclosure.
- G. AC Power - A DIN rail mounted AC power distribution terminal block group for two separate 120VAC circuits shall be provided, one for the FLEX-IO controls, and one for a utility circuit. A DIN rail mounted 120VAC utility box w/receptacle shall be provide and wired to the utility circuit. These terminal blocks shall provide an AC disconnect method and fuses for protection of each circuit. Fused terminal blocks, 5x20mm, shall be provided for AC power distribution to the power supplies and any devices requiring AC within the cabinet.
- H. DC Power Supplies - DIN rail mounted 24 VDC power supplies, SOLA/HEVI DUTY SDN series, shall be provided for the FLEX-IO modules. Separate power supplies for analog modules and digital modules are required. Power supply current capacity shall be sized for the Gas Panel loads. DIN rail terminal fuses blocks and 5x20 mm fuses shall be provided for distributing power to DC circuits and overload protection. AB guidelines shall be followed for power wiring to the modules.
- I. Brooks Flow Controllers – These flow controllers are not loop powered and as such require a separate 24VDC power source. The vendor shall wire the power for these devices to fused terminal blocks in the controls enclosure, with the 24VDC analog power supply as the source.
- J. Device Wiring - Vendor shall wire the FLEX-IO modules to the instruments and valves in the Gas Panel. Refer to the AB FLEX-IO literature for field device wiring. Signal wiring shall use twisted-shielded pair, stranded, PVC chrome jacket, polyethylene insulation, 100% foil shield with drain wire, of an appropriate gauge for connection to instrument connectors and devices, 22 GA Minimum.

- K. Grounding - A ground bus, isolated from the chassis and power ground shall be provided. All signal wire shields from the FLEX-IO modules shall be terminated on this bus via an individual conductor per module. Other signal commons and power supply commons shall be individually connected to this bus via separate conductors. Standard, accepted grounding and shielded practices shall be used to minimize electrical noise.
- L. Labeling - All cables shall be identified with a unique number on each end identifying, as a minimum, the tag name of the instrument. Individual conductors shall be color coded and identified with a descriptive label uniquely identifying the destination. Refer to the reference SRD for cabling.

Each terminal block shall be labeled with the tag name of the device along with the conductor label.

Lamacoid name plates fastened to the mounting surface or door shall be provided for the following:

1. Each FLEX-IO module shall have a label identifying the slot number according to the IO list. Install the label on the enclosure panel adjacent to the module base. Label Dimensions – 0.5” high, 0.175” high text.
2. The Controlnet adaptor shall be labeled adjacent to the module base, “TGT_CTL:PLC8730”, Label Dimensions – 0.5” high, 0.175” high text.
3. The controls enclosure exterior shall be labeled, on the enclosure door, center, top, “TGT_CTL:CAB8730” Label Dimensions - 2” high, 0.5” high text.

M. Helium Distribution Panel IO LIST and FLEX-IO Modules

INSTRUMENT	DESCRIPTION	TAG	TYPE	MODULE	SLOT	CHAN
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT3231	AI-MA	1794-IE8	0	0
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT2521	AI-MA	1794-IE8	0	1
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT2545	AI-MA	1794-IE8	0	2
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT1021	AI-MA	1794-IE8	0	3
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT3230	AI-MA	1794-IE8	0	4
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT2021	AI-MA	1794-IE8	0	5
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT1521	AI-MA	1794-IE8	0	6
FLOW CONTROLLER	FLOW MEASUREMENT	TGT_HE:FT3064	AI-MA	1794-IE8	0	7
SPARE	SPARE ANALOG INPUT	-	AI-MA	1794-IE4xOE2	1	0
SPARE	SPARE ANALOG INPUT	-	AI-MA	1794-IE4xOE2	1	1
SPARE	SPARE ANALOG INPUT	-	AI-MA	1794-IE4xOE2	1	2
SPARE	SPARE ANALOG INPUT	-	AI-MA	1794-IE4xOE2	1	3
SPARE	SPARE ANALOG OUTPUT	-	AO-MA	1794-IE4xOE2	1	4

SPARE	SPARE ANALOG OUTPUT	-	AO-MA	1794-IE4xOE2	1	5
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:ACV1521	AO-MA	1794-OF4I	2	0
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:FCV2545	AO-MA	1794-OF4I	2	1
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:ACV2021	AO-MA	1794-OF4I	2	2
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:FCV1021	AO-MA	1794-OF4I	2	3
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:FCV3231	AO-MA	1794-OF4I	3	0
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:ACV2521	AO-MA	1794-OF4I	3	1
FLOW CONTROLLER	FLOW CONTROL VALVE COMMAND	TGT_HE:FCV3230	AO-MA	1794-OF4I	3	2
SPARE	SPARE ANALOG OUTPUT	-	AO-MA	1794-OF4I	3	3
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3216	DO-DC	1794-OB8EP	4	0
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3219	DO-DC	1794-OB8EP	4	1
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3217	DO-DC	1794-OB8EP	4	2
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FCV3064	DO-DC	1794-OB8EP	4	3
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3203	DO-DC	1794-OB8EP	4	4
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3205	DO-DC	1794-OB8EP	4	5
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:PY8061	DO-DC	1794-OB16E	4	6
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3214	DO-DC	1794-OB8EP	4	7
SOLENOID VALVE	BLOCK VALVE OPEN/CLOSE	TGT_HE:FY3215	DO-DC	1794-OB8EP	5	0
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	1
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	2
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	3
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	4
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	5
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	6
SPARE	SPARE DIGITAL OUTPUT	-	DO-DC	1794-OB8EP	5	7
CONTROLNET ADAPTER	COMMUNICATIONS TO REMOTE PLC PROCESSOR	-	CONTROLNET	1794-ACN15	-	-

2.4 SERVICE GALLERY PANEL, OPERATOR GALLERY PANEL, PROTON BEAM WINDOW PANEL CONTROLS AND INSTRUMENTATION TERMINATION ENCLOSURE AND WIRING INSTALLATION

- A. Termination Enclosure - Vendor shall supply and install a NEMA 4 termination enclosure, Hoffman or equal, on each of the above panels to house electrical instrument termination blocks. Vendor shall provide din rail terminal blocks on which panel instruments and controls are terminated. This rail will serve as a common connection point for all devices in the panel to IO modules in a remote PLC cabinet. Refer to the IO list for devices to be connected.

The terminal blocks shall be separated into the following labeled groups:

- Analog input
 - Analog Outputs
 - Digital Inputs
 - Digital Outputs
- B. Location - The termination enclosure shall be mounted in a location on the front the panel where access is unobstructed and that is easily accessible.
- C. Equipment within the controls enclosure shall be DIN rail mounted in a location where access is unobstructed with internal devices easily accessible from the front of the enclosure.
- D. Wire duct shall be provided for cable routing within the enclosure. Wire duct for cable entry to the cabinet shall be provided in a clear area on the top or side of the enclosure for separate power and signal conduit entry.
- E. Device Wiring - Vendor shall wire the terminal blocks to the instruments and valves on the Gas Panel. Signal wiring shall use twisted-shielded pair, stranded, PVC chrome jacket, polyethylene insulation, 100% foil shield with drain wire, of an appropriate gauge for connection to instrument connectors and devices, 22 GA. minimum.
- F. Brooks Flow Controllers – These flow controllers are not loop powered and as such require a separate 24VDC power source. The vendor shall wire power cables for each of these devices to separate, labeled terminal blocks groups in the termination enclosure. The power source will be from the remote PLC cabinet.
- G. Ground Bus – An isolated ground bus shall be provided. All signal wire shields shall be tied to this bus. Standard, accepted grounding and shielded practices shall be used to minimize electrical noise.
- H. Labeling - All cables shall be identified with a unique number on each end identifying, as a minimum, the tag name of the instrument. Individual conductors shall be color coded and identified with a descriptive label uniquely identifying the destination. . Refer to the reference SRD for cabling.

Each terminal block shall be labeled with the tag name of the device along with the conductor ID.

9. GAS PANEL IO LIST, DEVICE TERMINATIONS TO TERMINAL BLOCK

INSTRUMENT TYPE	TAG	GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT3080	OPERATOR GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT3040	OPERATOR GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3084	OPERATOR GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3083	OPERATOR GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY1783	OPERATOR GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT1791	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY2786	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY2785	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY1790	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY1789	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY1788	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY1787	PROTON BEAM AND VACUUM PUMP GAS PANEL
SOLENOID VALVE	TGT_HE:FY1786	PROTON BEAM AND VACUUM PUMP GAS PANEL
LEVEL TRANSMITTER	TGT_HE:LI5122	SERVICE GALLERY GAS PANEL
LEVEL TRANSMITTER	TGT_HE:LI5121	SERVICE GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT3031	SERVICE GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT3030	SERVICE GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT3029	SERVICE GALLERY GAS PANEL
PRESSURE TRANSMITTER	TGT_HE:PT1166	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3223	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3222	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3221	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY3220	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY1785	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY1784	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY1782	SERVICE GALLERY GAS PANEL
SOLENOID VALVE	TGT_HE:FY1781	SERVICE GALLERY GAS PANEL

PART 3 - EXECUTION

3.1 FABRICATION

- A. Protect cleanliness and factory sealing of component connections throughout the receiving, storage and installation process.
- B. All metal edges shall be de-burred.
- C. All metal parts of the panel, excluding pre-manufactured components, shall be painted with primer and epoxy enamel paint.
- D. All electrical equipment, including the inside of terminal boxes, shall be cleaned after final connections are made and prior to securing covers in place. "Touch-up" painting of equipment shall be performed by the Vendor on any scratched or blemished surfaces.
- E. All piping shall be un-insulated unless otherwise indicated.
- F. Mark piping with flow direction arrows and service color coding. Use durable commercial decals, applied with the face forward towards the normal maintenance access side (back) of the panel.

- G. Mount large components (dome regulators, large valves and relief devices) on pipe rack type supports beneath the panel face. Anchor and support relief devices.

3.2 ASSEMBLY

- A. Materials and equipment shall be installed in accordance with the approved recommendations of the manufacturer. The installation shall be accomplished by workmen skilled in their own particular crafts, and all work shall be conducted and finalized in a manner which is consistent for all valve panels.

3.3 CABLE AND WIRE INSTALLATION AND ROUTING

- A. All wires and cable shall be furnished and installed in accordance with the specifications, the manufacturer's written instructions, and the National Electrical Code
- B. All wires and cables shall be continuous from origin to terminal strips without splices. Cable shields shall be continuous and neither grounded or interrupted along its path and shall be suitably insulated, except at points of termination.
- C. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
- D. All electrical wires and cables from devices on the panel shall be run in RGS conduit to a raceway that routes all wires to the controls/termination enclosure. Install raceway in horizontal and vertical orientation to neatly route wiring. Refer to the reference cabling SRD for requirements for basic materials and methods.
- E. Conduit connections to devices that can be disconnected for servicing shall be made up with liquidtight flexible conduit of 12" length or less. Flexible conduit may also be used for short sections where required for difficult runs.
- F. All applicable electrical safety standards and codes shall be followed, particularly in regard to safety of machinery. Guard and cover any exposed terminations carrying greater than 24 VDC, for example.
- G. Analog signals shall be routed separately from digital signals, and both shall be separated from AC power conductors.
- H. Terminal blocks shall be DIN rail mount screw clamp type, with 6 mm nominal width, such as Wiedmuller, Woertz or equal.
- I. Terminal blocks shall be DIN rail mount screw clamp type, with 6 mm nominal width, such as Wiedmuller, Woertz or equal.
- J. All wire bundles shall be supported in plastic wire duct.
- K. Instrumentation wires and cables shall be routed separately from power wires so as to minimize electrical interferences.
- L. Care shall be exercised while installing wires and cables so as not to damage conductors, insulation, or shielding or to otherwise alter its mechanical or electrical properties. All wires and cable shall be suitably grouped together and routed in suitably sized enclosed raceways.